SHORT COMMUNICATIONS

A PRELIMINARY RADIO SURVEY OF PLANETARY NEBULAE SOUTH OF DECLINATION 24 DEGREES*

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This paper presents the preliminary results of a survey intended to measure the radio emission of about 70 of the brighter planetary nebulae accessible to the 64 m reflector operated by the Division of Radiophysics, CSIRO, at Parkes, N.S.W.

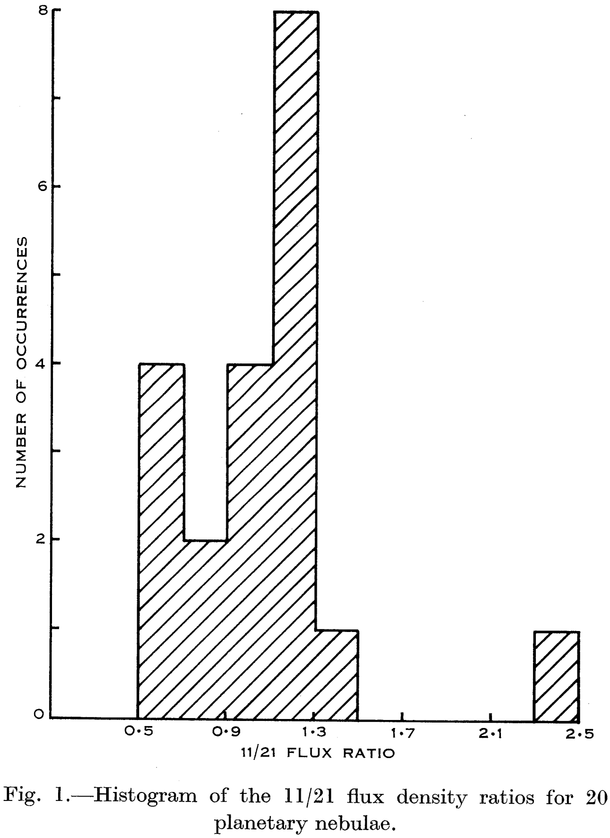

Fig. 1.—Histogram of the 11/21 flux density ratios for 20 planetary nebulae.

Much of the observational work has already been completed at a wavelength of 11 cm, and incomplete but useful data are available at 21 and 48·5 cm.

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TABLE 1

AVERAGE FLUX DENSITY FOR OBSERVED PLANETARIES

Planetary Identification	Average Flux Density ($10^{-26}Wm^{-2}(c/s)^{-1}$)			No. of Scans in Average			Remarks
	11	21	48·5 cm	11	21	48·5 cm	
NGC 246	0·24 (0·18)	0·20 (0·19)	—	17	4	—	α scans only at 21 cm, δ scans confused. Integrated fluxes from optical size
NGC 1535	0·21	0·14	—	12	12	—	
J 320	<0·06	—	—	26	—	—	δ scans only
IC 418	1·29	1·02	—	11	8	—	
NGC 2022	0·08	—	—	13	—	—	
Mh	0·51 (0·27)	<0·16	—	11	9	—	21 cm affected by confusion. Integrated flux from optical size
IC 2165	0·30	—	—	6	—	—	
NGC 2392	0·25	—	—	6	—	—	
W	<0·04	—	—	15	—	—	δ scans only
NGC 2438	0·11	—	—	16	—	—	
NGC 2440	0·46	—	—	6	—	—	
NGC 2610	<0·06	—	—	16	—	—	δ scans only
IC 2448	0·09	0·09	—	20	8	—	δ scans only at both 11 and 21 cm
NGC 2792	0·13	<0·13	—	6	8	—	21 cm affected by confusion. δ scans only at 21 cm
NGC 2818	<0·11	—	—	5	—	—	δ scans only
NGC 2867	0·28	0·22	—	15	14	—	
A 22	<0·08	—	—	7	—	—	δ scans only
IC 2501	0·28	—	—	10	—	—	
NGC 3132	0·18	0·28	—	16	13	—	
NGC 3195	0·06	—	—	20	—	—	δ scans only
NGC 3211	0·10	<0·06	—	8	6	—	δ scans only at both 11 and 21 cm
NGC 3242	0·81	1·15	1·74	4	8	16	
IC 2621	0·16	<0·17	—	16	16	—	21 cm affected by confusion
NGC 3918	0·84	0·69	<0·76	8	8	8	48·5 cm affected by confusion
NGC 4361	0·20	0·21	—	16	8	—	δ scans only at 21 cm
NGC 5189	0·36	0·41	—	8	9	—	
NGC 5307	<0·08	—	—	8	—	—	δ scans only
IC 4406	0·16	<0·13	—	8	20	—	21 cm affected by confusion

NGC 5882	0·34	0·51	—	8	8	—	
Sh	<0·11	<0·54	—	16	8	—	11 and 21 cm affected by confusion
NGC 6072	0·10	—	—	8	—	—	δ scans only
IC 4593	0·11	0·19	—	20	9	—	
NGC 6153	0·62	0·50	<2·06	4	4	6	48·5 cm affected by confusion. δ scans at 21 cm confused
NGC 6210	0·43	0·38	—	6	8	—	
IC 4634	0·12	0·21	—	8	4	—	δ scans only at 11 cm. δ scans at 21 cm confused
NGC 6309	0·18	—	—	8	—	—	δ scans only
NGC 6326	0·10	—	—	20	—	—	δ scans only
NGC 6369	1·97	—	2·26	4	—	16	flux at 48·5 cm may be affected by confusion
NGC 6445	0·48	—	<2·13	4	—	10	48·5 cm affected by confusion
D	<0·08	—	—	8	—	—	δ scans only
NGC 6537	0·69	—	—	4	—	—	
NGC 6563	0·11	—	—	8	—	—	δ scans only
NGC 6565	<0·11	—	—	8	—	—	11 cm affected by confusion
NGC 6572	1·07	0·44	<0·32	8	8	8	δ scans confused at 48·5 cm, α scans clear
NGC 6567	0·14	—	—	8	—	—	
NGC 6578	<0·06	—	—	8	—	—	δ scans only
IC 4699	<0·05	—	—	12	—	—	δ scans only
NGC 6629	0·17	—	—	8	—	—	δ scans only
IC 4732	0·15	—	—	8	—	—	δ scans only
IC 4776	<0·06	—	—	8	—	—	δ scans only
CD–32° 14673	<0·07	—	—	7	—	—	δ scans only
NGC 6741	0·24	—	—	6	—	—	source appears extended; possibly distorted by galactic structure
NGC 6778	0·10	—	—	20	—	—	δ scans only
NGC 6781	0·26	—	—	6	—	—	
NGC 6790	0·09	—	—	12	—	—	δ scans only
NGC 6803	0·08	<0·14	—	19	8	—	21 cm affected by confusion. δ scans only at both 11 and 21 cm
NGC 6807	0·05	—	—	12	—	—	δ scans only
NGC 6818	0·34	0·34	—	5	8	—	
NGC 6853	1·81 (1·19)	1·48 (1·25)	1·51	7	8	16	integrated fluxes obtained from optical size
NGC 6891	0·09	<0·13	—	20	8	—	21 cm affected by confusion
IC 4997	0·12	<0·17	—	16	12	—	21 cm affected by confusion
NGC 6905	0·09	<0·12	—	6	3	—	δ scans only at 11 cm, α scans only at 21 cm
NGC 7009	0·79	0·65	0·72	8	8	7	δ scans at 21 cm confused
NGC 7293	1·60 (0·57)	1·60 (0·93)	2·06	14	10	12	11 cm integrated flux obtained from brightness contours

The observations were conducted by scanning over a range of about four beamwidths centred on the position of the planetary. The beamwidths were 7·5, 14, and 32 min of arc to half-power points at 11, 21, and 48·5 cm respectively. If possible, both right ascension and declination scans were obtained. In order to reduce the effects of noise fluctuations, a number of scans ranging between 4 and 26 were taken of each planetary, the receiver output being recorded digitally on paper tape. The scans were later averaged in a computor.

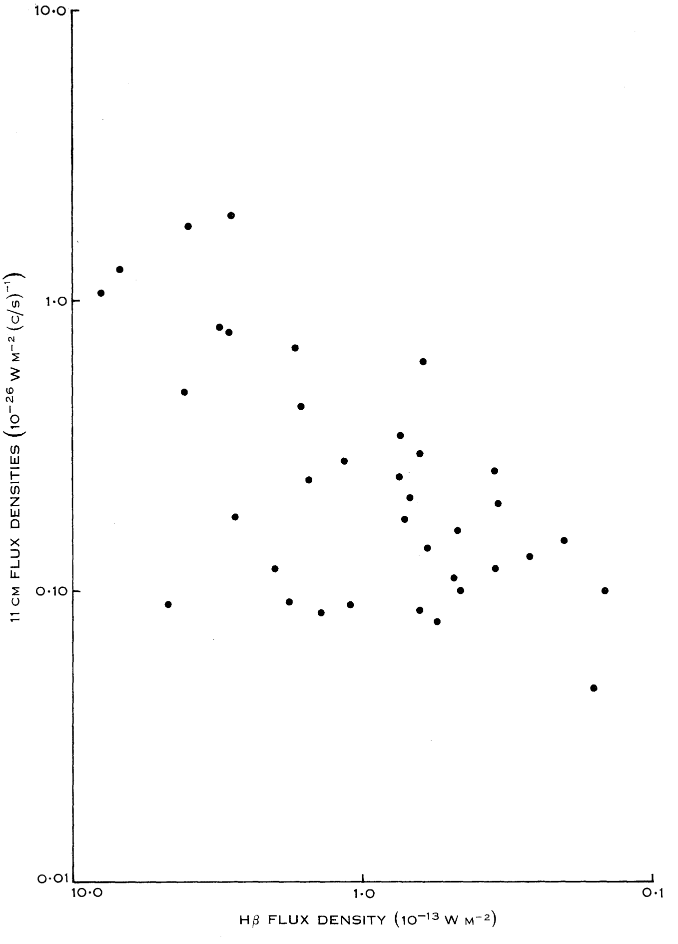

Fig. 2.—Correlation between the Hβ and 11 cm flux densities for 36 planetaries.

The first column of Table 1 identifies the planetary in order of right ascension by its NGC or IC number. If it is not listed in either of these catalogues, we have used the designation of Vorontsov-Vel'yaminov (1962).* In the next three columns,

* Vorontsov-Vel'yaminov, B. A. (1962).—"A New Catalogue of Planetary Nebulae." Soobshcheniya Gosud. Astron. Inst. im P.K. Shternberga, No. 118, pp. 3–35.

we have listed the average flux densities, the number of scans used in the averages being given in the following three columns. For four of the planetaries it was necessary to correct the observed peak deflections of the scans for resolution effects; in these cases the uncorrected fluxes are shown in brackets.

An absolute flux density calibration of the equipment has been obtained at each of the three wavelengths by observations of the radio source Hydra-A. The planetary fluxes of Table 1 are based on flux densities for the primary calibrator of 23·5, 45, and 91 flux units at wavelengths of 11, 21, and 48·5 cm respectively. It is believed that errors in the assumed flux values for Hydra-A should not contribute systematic errors to the planetary fluxes of more than 5%. A reasonably thorough investigation of the random errors to be expected because of noise fluctuations has permitted us to estimate the r.m.s. error in the final flux densities (allowing 5% for systematic effects). At 11, 21, and 48·5 cm these errors are 65%, 50%, and 15% respectively at the lowest flux densities tabulated, while, at the highest flux densities, the errors are about 10% on all three wavelengths. This discussion neglects the effects of confusion, which may be serious at 20 and 48·5 cm.

Some preliminary analyses of the planetary flux densities are shown in Figures 1 and 2. Firstly, the 11/21 flux ratios for 20 planetaries are plotted as a histogram in Figure 1. The majority of the planetaries appear to be grouped around a ratio of unity (the mean is 1·08), which is to be expected for an optically thin nebula. However, NGC 6572 with a ratio of 2·43 and NGC 3132, 3242, 5882, IC 4593, 4634 with ratios in the range 0·57–0·71 show that the physical conditions in some planetaries may not be so simple. Finally, in Figure 2 we plot the Hβ flux density, corrected for interstellar absorption, against the 11 cm flux densities for 36 objects. It is evident that a relationship does exist, although it is far from an ideal one.

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